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THE MICA INK-CAP OR GLISTENING COPRINUS

F. C. STEWART

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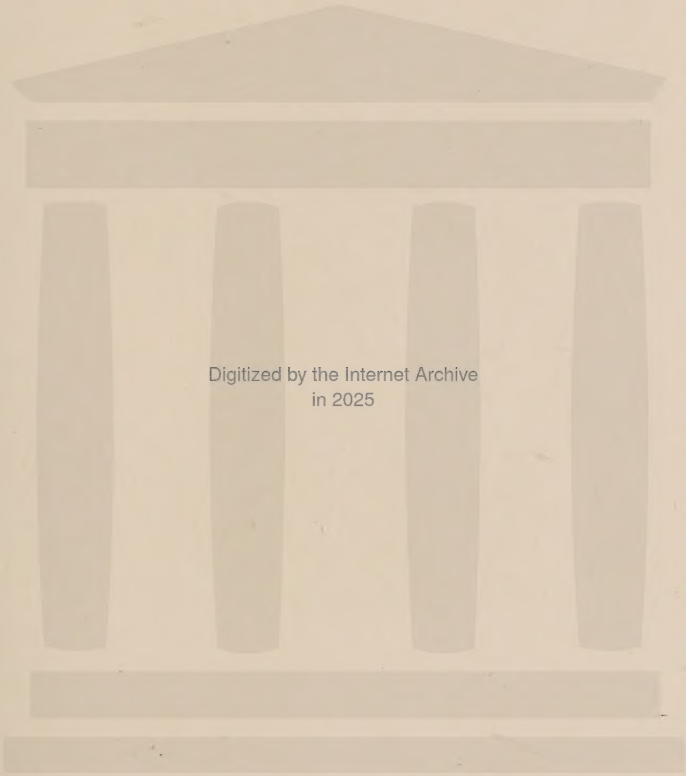

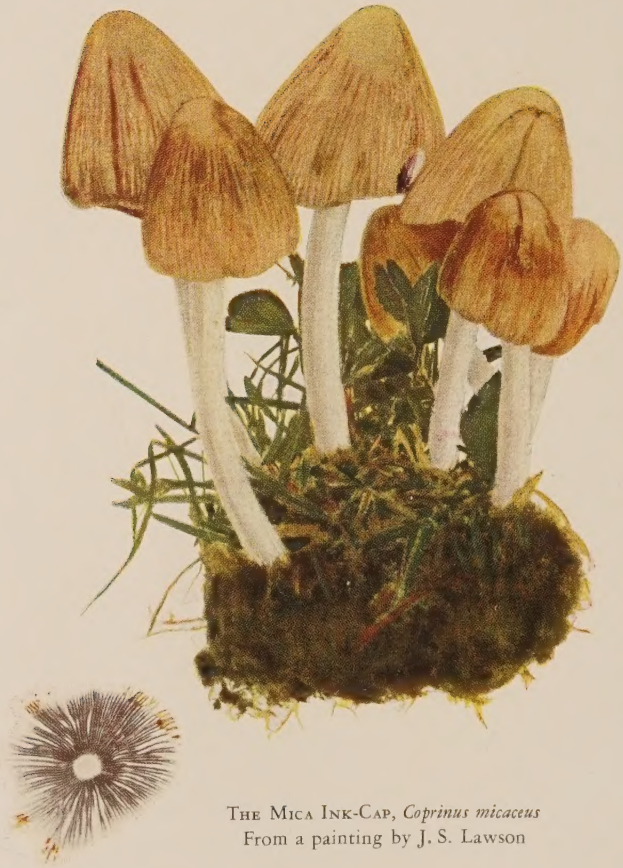

THE MICA INK-CAP, *Coprinus micaceus*
From a painting by J. S. Lawson

BULLETIN No. 535

THE MICA INK-CAP OR GLISTENING COPRINUS

F. C. STEWART

ABSTRACT

A semi-popular account of *Coprinus micaceus* with special reference to its identification and its use for food. It is said to be one of the most important edible fungi of New York. There are eight or ten successive crops between May 1 and October 1. Thirty-eight pounds of the fungus were gathered about a single large elm stump in one season. During autodigestion from 72 to 74 per cent of the weight of the caps is transformed into liquid. When pure, this liquid is light reddish brown, but it usually appears to be black due to the admixture of spores and particles of the undigested residue which is coal black.

INTRODUCTION

The number of kinds of wild mushrooms is so great that only the specialist in mycology who makes the fleshy fungi a life study can be expected to know even a majority of them. However, everybody should know a few kinds. In these days, when so much is known about the wonderful world in which we live, and when such knowledge is so easily acquired, acquaintance with at least a few of the common wild mushrooms should be made a part of every person's education.

One of the mushrooms which everybody in the State of New York should know is the mica ink-cap or glistening Coprinus (*Coprinus micaceus*). Everybody should know it because it grows abundantly in nearly all parts of the State and because it is good to eat.

A great deal has been written about the mica ink-cap. It has been described and illustrated many times. Accounts of it are to be found in most of the mushroom books and in numerous scientific articles on fungi. But much of that which has been written is out of print, too technical for the lay reader, or not readily accessible to the masses of the people. Believing that many New York people, both in the cities and in the country, have a real interest in edible fungi and desire information concerning them, it has seemed to the writer that the publication of yet another semi-popular account of the mica ink-cap is not only excusable but highly desirable. Accordingly, the present

bulletin has been prepared. The technical reader will find in it little that is new. Its chief purpose is to describe the mica ink-cap so fully and so clearly as to make its identification easy and thereby popularize the plant as an article of food.

BRIEF GENERAL ACCOUNT

The mica ink-cap is a small, tan or buff-colored fungus which grows in dense clusters on the ground about stumps or over buried wood. It appears in successive crops following rains from early spring until freezing weather in the fall. It grows almost anywhere that stumps are found. In cities and villages it appears at our very doors, growing abundantly in lawns about the stumps of shade trees which have been cut down or over the buried roots of stumps which have been removed.

It is an edible fungus of good quality and perfectly safe. Altho of small size and highly perishable, it is, economically, one of our most important wild mushrooms because of its common occurrence and abundant numbers. Hard (5)[1] says, "For eating it is without doubt the best mushroom that grows." Its edibility was first established by Peck (13) in 1875.

NAME

When the mica ink-cap reaches maturity its gills become transformed into an ink-like liquid. From this peculiarity it takes the name "ink-cap." However, the name ink-cap, alone, is not sufficiently distinctive because a considerable number of other mushrooms produce inky liquid in the same manner. To get around this difficulty use has been made of another peculiarity of the fungus, namely, the glistening particles which cover the young caps in wet weather; and the word "mica" is prefixed giving us "mica ink-cap." Glistening Coprinus, another common name, also refers to the glistening particles on the young caps. The botanical name of the fungus is *Coprinus micaceus*.

DESCRIPTION OF *COPRINUS MICACEUS*

In describing the mica ink-cap we shall employ a method much used by the late Dr. C. H. Peck. This consists in presenting first a condensed technical description and following with a more elaborate account couched in popular language.

[1]Refers to Literature Cited, page 29.

TECHNICAL DESCRIPTION

For the technical description use will be made of that prepared by Dr. L. H. Pennington (15) for Kauffman's Agaricaceae of Michigan. It is as follows:

"*Pileus* 4–6 cm. across, submembranaceous, elliptical then campanulate, coarsely striate, disk even, margin usually more or less repand, ochraceous-tan, disk darker, when young densely covered with minute glistening particles which usually soon disappear. *Gills* sub-crowded, lanceolate, adnexed, whitish, then brown, finally nearly black. *Stem* 5–7 cm. long, 4–6 mm. thick, equal, even, hollow, silky white. *Spores* 7–8 x 4–5 micr., dark brown in mass."

POPULAR ACCOUNT

The cap, or pileus as it is also called, varies in shape at different stages of growth. When it first appears above ground it is ellipsoidal. A few hours later, when partially expanded, it will be bell-shaped; and still later, when fully expanded, and the gills have been transformed into ink-like liquid, it will be nearly flat with the margin rolled upward.

The color of the cap, also, varies considerably with the weather conditions and age of the plant. In damp, cloudy weather young and middle-aged plants are dingy yellowish or light tan. (See color plate.) When exposed to wind or sunshine which dries them out they rapidly become lighter in color, often light buff or light cream color. The center of the cap, known as the disk, is usually darker, tho sometimes lighter, than other parts. Owing to the black remains of the disintegrated gills upon their upturned margins, mature caps are black, ragged, and unsightly.

In the middle or bell-shaped stage the caps are commonly from an inch to one and one-fourth inches in length. The average weight of the caps when in the bell-shaped stage varies from one twenty-eighth to one-ninth of an ounce. The surface of the cap is traversed by numerous parallel furrows (striae) which extend from the margin upward. These furrows do not quite reach the summit or center of the cap, so there is left on the central portion of the cap a small area about three-eights of an inch in diameter without furrows or ridges. Hence the description, "disk even." The margin of the cap is more or less wavy, lobed, or scalloped. In damp weather the young caps are covered with minute glistening particles resembling particles of mica. Altho these mica-like particles may be seen with the unaided eye, a

low-power magnifier greatly facilitates their observation. As the plants develop the glistening particles rapidly disappear, particularly in dry weather. The flesh of the cap is very thin. Even on the disk, where it is thickest, it is only about one-twelfth of an inch in thickness. In color it may be either whitish or brownish and water-soaked.

The gills (lamellae) make up the greater part of the bulk of the cap. They are quite close together, about one-fourth inch wide in medium-sized plants and attached to the stem by a narrow point (adnexed). Their color is at first whitish, then brown, and finally almost black. The change in color begins at the outer end of the gill and moves upward and backward toward the stem. The edges of the gills of young plants are thickly covered with glistening particles like those on the caps, giving them a frosted appearance when seen under a hand lens. When the gills commence to change color the glistening particles on the edges disappear, but with the aid of a hand lens and good light one may then detect similar bodies projecting from the sides of the gills into the spaces between the gills. Buller (2, pp. 341–342 and 346–351), who has described and illustrated these two kinds of glistening bodies, calls them cystidia. The former, he calls marginal cystidia, the latter, pleuro-cystidia. They are interesting objects, but have small diagnostic value because similar bodies occur on the gills of other species of Coprinus. When seen thru a compound microscope they appear as elliptical, thin-walled, hyalin cells of enormous size. Usually, they are devoid of contents, but occasionally one is found which shows a network of delicate protoplasmic strands. According to our observation, the pleuro-cystidia are considerably larger than the marginal cystidia and longer in proportion to their width. The former measure 30 to 60 by 65 to 120 microns, and the latter 40 to 65 by 120 to 210 microns. They are frequently larger at one end than at the other and some are slightly sausage-shaped.

With the change in the color of the gills comes, also, their so-called deliquescence or autodigestion, during which they are almost completely transformed into an ink-like liquid. In damp weather autodigestion proceeds rapidly and the cap soon becomes black and slimy and disappears. On the other hand, in dry weather, autodigestion is arrested and the cap shrivels and dries up much like the caps of other thin-fleshed mushrooms.

As in other agarics (gill fungi), countless numbers of minute reproductive bodies called spores are produced all over the surface of the

gills. In the technical description the size of the spores is given as "7–8 x 4–5 microns." Since a micron is about 0.00004 of an inch, the length of the spores is from 0.00028 to 0.00032 inch and their width from 0.00016 to 0.0002 inch. Objects so minute as this can be seen individually only when highly magnified. Consequently, their observation is limited to those who have the use of compound microscopes. The color of the spores when seen in mass is dark brown, almost black. (See color plate.) Under the compound micrpscope they appear reddish brown. Buller (2, pp. 346–351) has described the manner in which the spores are discharged.

The stem of the mica ink-cap, in full-grown plants, varies in length from 2 to 3 inches and in diameter from one-sixth to one-fourth of an inch. It is uniform in size thruout its whole length (equal), even on the surface, hollow, and silky white. Sometimes, a slight ring or annulus may be detected on the stems of young plants at the time the margin of the cap is breaking away from the stem.

Anybody who will give close attention to the above description and to the plates in this bulletin should be able to identify the mica ink-cap with a fair degree of certainty. It may be confused with certain other small species of Coprinus, but no harm will result because all Coprini are edible. Also, it has considerable resemblance to the uncertain Hypholoma (*Hypholoma incertum* Pk.) which is about the same size and color (particularly when young) and grows in similar places; but this, too, is edible. *The mica ink-cap has no resemblance whatever to any deadly poisonous species.*

SPORE PRINTS

That the spores of *Coprinus micaceus* are dark colored is obvious to anybody who has examined the mushroom carefully. But if one wishes to know the exact color of the spores it is necessary to catch a quantity of them on white paper, that is, obtain what is known as a spore print.

The usual method of obtaining spore prints of mushrooms is to cut off the stem close to the gills, place the cap gills downward on paper, and cover it with an inverted tumbler, bowl, or other similar dish. When, after a few hours, the cover is removed and the cap carefully lifted it will be found that the falling spores have formed a thin layer on the paper. The color of this spore deposit is the color of the spores "in mass," a term much used in descriptions of fleshy fungi.

With some kinds of mushrooms it is possible to obtain beautiful spore prints in which the outlines of the gills have been neatly traced by the falling spores. With *Coprinus micaceus* it is easy enough to obtain a spore deposit which will show the color of the spores, but to obtain spore prints showing well the outlines of the gills is difficult. Owing to the bell-shaped form of the pileus at the beginning of spore fall only the outer ends of the gills come into contact with the paper. Also, the spores fall first from the outer ends of the gills and cause a heavy deposit of spores around the margin of the spore print while the central portion is still blank. If the cap is left in place until the central portion of the spore print is filled in the spore deposit around the margin will become too thick. Moreover, when the caps are allowed to set a long time autodigestion begins and drops of liquid fall on the spore print and ruin it.

The spore print shown in the lower left-hand corner of the color plate was made by a method described by Buller (2, p. 238). A well-expanded cap whose gills had already shed a large part of their spores and begun their autodigestion was placed gills downward on white paper under a tumbler for 25 minutes. The resulting spore print was "fixed" for color reproduction by Mr. J. S. Lawson, Museum Preparator of this Station.[2]

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[2]Method for Fixing Spore Prints

Formula for fixative:

White shellac (powdered)	½ oz.
Methyl alcohol, c. p	8 ozs.

Shake and let stand a few hours. Pour off the supernatant liquid and use it as a fixative. Add more methyl alcohol and repeat until the shellac is exhausted.

With a broad camel's hair brush, saturate thoroly with fixative the back of the paper upon which the spore print has been made until dampness shows thru the paper and darkens some of the spore masses. Let it dry thoroly to fix all of the spores to the surface of the paper which are in contact with it. Lay the spore print horizontally, face up. Direct over it a very fine spray of the fixative from a bulb atomizer, forcing the larger drops beyond the print and permitting the finer spray to settle down upon it vertically. Any large drops falling on the print may dislodge the spores and blur the print. The process should be repeated two or three times, in each case applying only a small amount of the fixative with time to dry between applications. Lastly, apply a heavier spray in the same manner until the whole surface of the print appears wet. When this is dry hold the print on a slant. Take the brush again, loaded with fixative, and draw it across the paper above the print, permitting the liquid to float down over it. If the print is not completely covered invert it and spread the fixative around it with the brush until the surface is covered. Care should be taken not to touch

HABIT

Its habit of growth is described as "densely cespitose;" that is to say, it usually grows in dense clusters containing many individual plants. The stems of a dozen or more plants seemingly spring from the same point. Often hundreds of plants are crowded together on a space a foot square, and colonies are sometimes found which thickly cover areas of 2 or 3 square feet. Large colonies are generally associated with large stumps, particularly large stumps which have been sawed off close to the ground and covered with 1 or 2 inches of soil.

HABITAT

The mica ink-cap always grows in close relation with dead wood of deciduous trees. Altho often found on the ground about the base of living trees, it has never been proved parasitic. The writer has frequently observed it growing around living trees of the silver maple (*Acer saccharinum*). In such cases it probably feeds upon dead roots. The writer has never observed it about the stumps of coniferous trees of any kind and knows of no record of its occurrence in connection with coniferous wood. The stumps of many kinds of deciduous trees are capable of supporting it. Some kinds bear it more frequently and more abundantly than others, but information is scant concerning the relative bearing capacity of different species of trees. From the writer's observations it would seem that elm and willow are favorites with the fungus and that it prefers silver maple to sugar maple. It appears probable that shallow-rooted trees are preferred to those that root deeply. In the great majority of cases the plants appear to spring from the soil about the stump, but they are connected with the wood below the surface of the soil by means of delicate white strands of mycelium. How thick a layer of soil the mycelium is able to traverse for the purpose of producing the fruit bodies is not known. Probably, the distance thru which it may go does not exceed a foot. When a colony of the fungus is found on the ground several feet from a stump (as often happens) one will discover upon digging into the

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the print with the brush. Dry the print thoroly, preventing large drops of the fixative from collecting on the surface of the paper.

The fixed spore print may be freely handled without damage or blurring. It may be cleaned with art gum and is very permanent. It has the advantage over prints made by the use of mucilage and gummed paper in that it is not readily damaged by wetting. If carefully done, with a minimum of fixative, few of the spores will collapse.—*J. S. Lawson.*

soil that a root from the stump lies only a few inches below the surface.

Only rarely are the fruit bodies found seated directly on the wood. Four times the writer has seen large colonies of fruit bodies growing on large prostrate elm trunks, but in all cases the situation was a damp one and the weather at the time unusually wet. In another case a large colony was found growing on the buttress roots of a large stump of the swamp maple (*Acer rubrum*) 18 inches above the surface of the soil. This stump stood in swampy ground and the weather was wet. Once a colony was observed on the bark of an elm stump 18 inches above the ground.

It is not uncommon to find the mica ink-cap springing up in lawns at a considerable distance from stumps or trees. In such cases one may be fairly certain that a tree once grew upon the spot and that the mushrooms have their origin in the decaying roots or other parts of the stump buried in the soil. However, there is the possibility that the fungus may be growing from buried timbers or pieces of wood which did not grow on the spot. The fungus has frequently been observed growing on the ground around the stubs of telephone poles which had been cut off even with the surface of the soil.

Generally speaking, *Coprinus micaceus* may be expected to occur wherever there are stumps of deciduous trees; but in deep forests where there is much decaying vegetable matter on the surface of the soil, as, for example, in the forests of the Adirondack Mountains, it is rarely found in quantity. Neither does it thrive among tall grass or weeds. The best places to look for it are in close-grazed stump pastures and in lawns from which shade trees have been removed. Stumps surrounded by bare ground in shady places are also very prolific. Those a few years old bear more abundantly than very old stumps in an advanced stage of decay.

AVERAGE WEIGHT OF THE CAPS

The weight of the caps varies with their size and age and also with the weather conditions. In damp weather a cap attains its maximum size and weight about the time the gills commence to turn brown. During the process of autodigestion, which begins at this time, the gills are transformed into a dark-colored liquid which either falls to the ground in drops or is evaporated into the air. In this way the caps may lose as much as 74 per cent of their weight (page 22). In

dry weather the caps readily dry out and lose weight even before autodigestion sets in.

The writer has counted and weighed several lots of caps for the purpose of learning the average weight of the caps when in the stage in which they are usually gathered for cooking, that is, about the time the gills begin to change color. Such lots of caps have always contained some in which autodigestion had already begun and others which were immature, but the majority were at maximum weight. The rule has been to cut off the stem at the margin of the cap as in the preparation of plants for cooking.

TABLE 1.—AVERAGE WEIGHT OF *Coprinus micaceus* CAPS.

DATE, 1925	NUMBER OF CAPS	AVERAGE WEIGHT IN GRAMS	NUMBER IN A POUND	REMARKS
May 2	26	2.91	156	First cutting; from elm stump; morning after a rainy night.
3	50	1.32	344	Second cutting; evening; plants dry; same colony as above.
5	16	0.94	483	Third cutting; same colony as above.
10	27	1.08	420	From another colony by same stump.
13	61	1.68	270	Several were overripe and dry.
July 2	156	1.13	401	First cutting of third crop; from sugar maple stump; morning.
Sept. 18	240	1.17	388	Some were quite young.

The average weight of the caps in these several collections varied from one-twenty-eighth to one-ninth of an ounce and the number required to make a pound from 156 to 483 (Table 1). From this it is plain that the plants are quite small. Yet, because of their frequent occurrence in readily accessible places and their habit of growing in large clusters, it is often easy to gather considerable quantities of them.

SEASON

Coprinus micaceus is a long-season mushroom. In New York it may be found after showers almost any time between early spring and freezing weather in the fall. Its largest crops are usually produced in May. It makes its first appearance about the time the horse chestnut leaves are unfolding and when forsythia and Norway maple are in bloom. Those who seek it in lawns may expect to find it first between the first and second mowings. At Geneva, these events

usually take place during the first week of May, but in some seasons a little earlier and in others a little later. Murrill (10) says *Coprinus micaceus* is usually the first fungus to appear in quantity in the spring. He records its appearance in Bronx Park, New York City, on April 9 in the exceptionally early spring of 1910.

Observations of the writer, made chiefly at Geneva, cover the past 14 years with the exception of 1916 and 1920. In 1912 the first specimens were found on May 4 growing beside a silver maple stump in a warm situation. In 1913 a colony of the fungus was found beside the same stump on April 28. In 1914 it first appeared by this stump on May 7. On the same date a fine colony was found near a willow bush in another locality. On May 2, 1915, 1 pound of caps was gathered in a sheep pasture. Some small clusters had been seen earlier but no record was made of the date. In 1917 the first specimens seen or heard of by the writer were found in a lawn under a willow bush on May 14. In 1918 the first specimens of the season were found on May 4 on the same spot. On April 21, 1919, large colonies of *C. micaceus* were found growing around four large stumps of silver maple in a lawn in Riverhead, Long Island. The plants were already old and withered. Probably, they had been in their prime on April 18. In the same lawn were two horse chestnut trees, one of which had not yet broken its buds, but on the other the buds had broken and the leaves had begun to separate. The flowers of Norway maple trees in the vicinity were barely open. They were not in full bloom until two days later. On April 24, 1919, several large colonies of the fungus were observed at Amsterdam. The first specimens seen at Geneva in 1919 were found on May 4, but they were already old. In 1921 the fungus was first seen about April 16 and a quantity cooked on April 23. In 1922 a large quantity was found on May 7, but other specimens had been seen earlier. In 1923 it first appeared by a large elm stump on May 14. In 1924 its first appearance in the same place occurred on May 13, and in 1925 on April 24. In 1926 old specimens were found at Ithaca on May 8, but none were seen at Geneva until May 9.

Data on the late occurrence of the fungus are less numerous. The latest dates recorded in our own notes are December 4 in 1922, December 3 in 1923, and November 7 in 1924. Murrill (11) reports it abundant on the grounds of the New York Botanical Garden at Bronx Park on December 1, 1922. This, he says, was due to warm weather and late fall rains following a period of dry weather.

YIELD AND NUMBER OF CROPS PER SEASON

Coprinus micaceus appears in successive crops thruout the season. The number of crops during the season and the length of the interval between crops varies with the weather conditions, especially the rainfall. Temperature is a factor, but much less important than rainfall. When showers are frequent and the temperature moderately high a new crop appears every eight or ten days. During periods of drought production is checked and often completely stopped, but is promptly resumed with increased vigor upon the coming of rain. In spring or summer a heavy shower following a period of drought is sure to bring out a crop of *Coprinus micaceus* within two or three days. In the fall the response to rain is less marked. The writer has been unable to confirm Peck's statement (14, p. 244) that it "sometimes seems to anticipate rain, starting to grow two or three days before a rainstorm." True, occasional clusters appear when there has been no rain for some time, and their appearance may be followed within two or three days by rain; but such plants are to be regarded as belated members of the crop which followed the preceding rain rather than as forerunners of the succeeding crop. It never happens in time of drought when there is a long interval between crops.

In the spring of 1923 the writer set out to determine how many crops of *C. micaceus* are produced under favorable conditions and how large a yield may be obtained from a single stump in the course of a season. Use was made of a large elm stump in a lawn on the Station grounds. The stump was 4 feet in diameter and free from decay when the tree was felled in September, 1917. It had produced a considerable quantity of the fungus during the preceding season. It was closely surrounded on all sides by grass which was kept cut short. (See Plate I.) During spells of dry weather the stump and surrounding soil were freely watered.

It was planned to gather and weigh all of the caps of *C. micaceus* growing around the stump during the entire season of 1923. The plants were to be harvested when at maximum weight and in the proper stage for cooking; that is, when the gills commence to turn brown. But owing to the rapidity with which the plants mature in warm weather and the fact that the numerous members of a colony do not all mature at the same time, it was found impracticable to harvest all of the plants at exactly the proper stage of maturity. In almost every gathering there were some plants which were too old and others which were too young.

For the proper harvesting of a crop from four to eight separate gatherings within a period of from two to five days were required. Often it was necessary to make two gatherings (morning and evening) per day, and sometimes a third gathering at noon was required. Harvesting was done by means of scissors used to sever the stem just below the margin of the cap. By far the greater portion of the yield came from the south and east sides of the stump. Only small scattered colonies appeared on the west and north. For some time the east and south sides bore alternately producing an almost continuous supply of mushrooms for the writer's table. Sometimes, when the rainfall was scant, considerable quantities of water were poured over the stump and surrounding soil, and it was demonstrated that even in very dry weather fair crops of this mushroom can be brought out by artificial watering. During the dry weather of August no watering was done and no mushrooms were obtained between August 4 and September 13. Had the stump been well watered during this period it is probable that the total yield for the season would have been considerably larger.

In all, 100 gatherings were made between May 15 and December 3 and a total yield of 38.25 pounds of mushroom caps obtained. The date and weight of each gathering are given in Table 2, which contains also the daily rainfall record from May 8 to December 3, 1923, and shows the dates on which the stump was watered. On the east side of the stump ten successive major crops of the fungus were produced and on the south side eight crops. Small gatherings from other places about the stump were made at various times. Some of these synchronized with the major crops occurring on the east and south sides, but others did not. Irregularity in the application of water during dry spells may have been partly responsible for this irregularity in the fruiting of the fungus.

The fourth crop on the east side and the sixth crop on the south side were brought out in very dry weather by artificial watering. Heavy watering between October 12 and 15 brought a small crop on the north and northeast on October 18, but nothing on the east or south sides. An unusually heavy rain (2.47 inches) on October 24 brought nothing anywhere, altho the mean temperature for the week commencing October 24 was a trifle higher than the mean temperature for the week preceding the heavy crop of May 15 to 18 and also higher than that for the week preceding December 3 when 2 ounces of caps were harvested. Evidently, the mycelium was about ex-

hausted, but that it was not dead is shown by the fact that good crops of mushrooms were produced again the following season.

TABLE 2.—RAINFALL AND YIELD OF *Coprinus micaceus* ABOUT AN ELM STUMP AT GENEVA, N. Y., MAY 8 TO DECEMBER 3, 1923.

DATE	RAINFALL AND WATERING	YIELD OF *Coprinus micaceus*		
		Time of harvesting	Yield	Remarks
	Inches		*Ounces*	
May 8	0.07			
9	0.38			
13	0.36			
15	0.46	Morning	21.0	
16	0.58	Morning	10.5	First crop on east side of the stump.
17		Morning	19.5	
18	0.30	Morning	14.0	
20		Morning	20.0	
21	0.37	Morning	20.0	First crop on south side.
22		Morning	8.0	
23		Morning	5.5	Part on east and part on south side.
24		Morning	5.0	On east side.
30	Watered	Morning	27.5	
31		Evening	19.0	Second crop on east side.
June 1		Noon	5.0	
2	Watered			
3	0.78	Evening	11.0	
4	0.10	Morning	8.0	
4		Evening	6.0	Second crop on south side.
5		Morning	7.0	
6	0.10	Evening	5.0	
7	0.28			
8	0.35	Morning	1.0	On the northwest.
9	0.50			
10		Morning	1.0	
10		Evening	9.0	
11		Morning	12.0	Third crop on east side.
11		Noon	9.0	
11		Evening	10.0	
12		Morning	11.0	

TABLE 2.—*Continued.*

DATE	RAINFALL AND WATERING	YIELD OF *Coprinus micaceus*		
		Time of harvesting	Yield	Remarks
	Inches		*Ounces*	
June 12		Evening	5.0	On the east and northeast.
13		Evening	2.0	
13		Evening	2.5	
14		Evening	6.5	
15		Morning	6.5	Third crop on south side.
15		Evening	6.0	
16	Watered	Evening	5.0	
17		Morning	1.5	
18	Watered			
20	Watered			
22		Morning	5.5	
22		Evening	6.5	
23		Morning	6.5	
23	Watered	Evening	1.5	Fourth crop on east side; weather very dry.
24		Morning	0.5	
25		Evening	1.5	
26	1.49	Noon	3.0	
27		Morning	1.5	
27		Evening	3.5	Fourth crop on south side.
28	0.25	Evening	2.5	
29	0.34	Evening	1.5	
30		Evening	3.5	
July 1		Morning	21.0	
1		Eevning	8.5	
2		Morning	10.0	
2		Evening	8.5	
3	0.18	Noon	4.0	Fifth crop on east side.
4	0.87	Morning	3.5	
5		Morning	2.5	
6	0.52	Morning	2.0	
7		Noon	1.5	
9		Morning	3.0	
10		Morning.	22.0	Sixth crop on east side.
10		Evening	9.0	
11		Morning	0.5	

PLATE I.—AN ELM STUMP BEARING MICA INK-CAP MUSHROOMS.

The stump is 4 feet in diameter. During the season of 1923 it produced 38 pounds of mushrooms. View from the south.

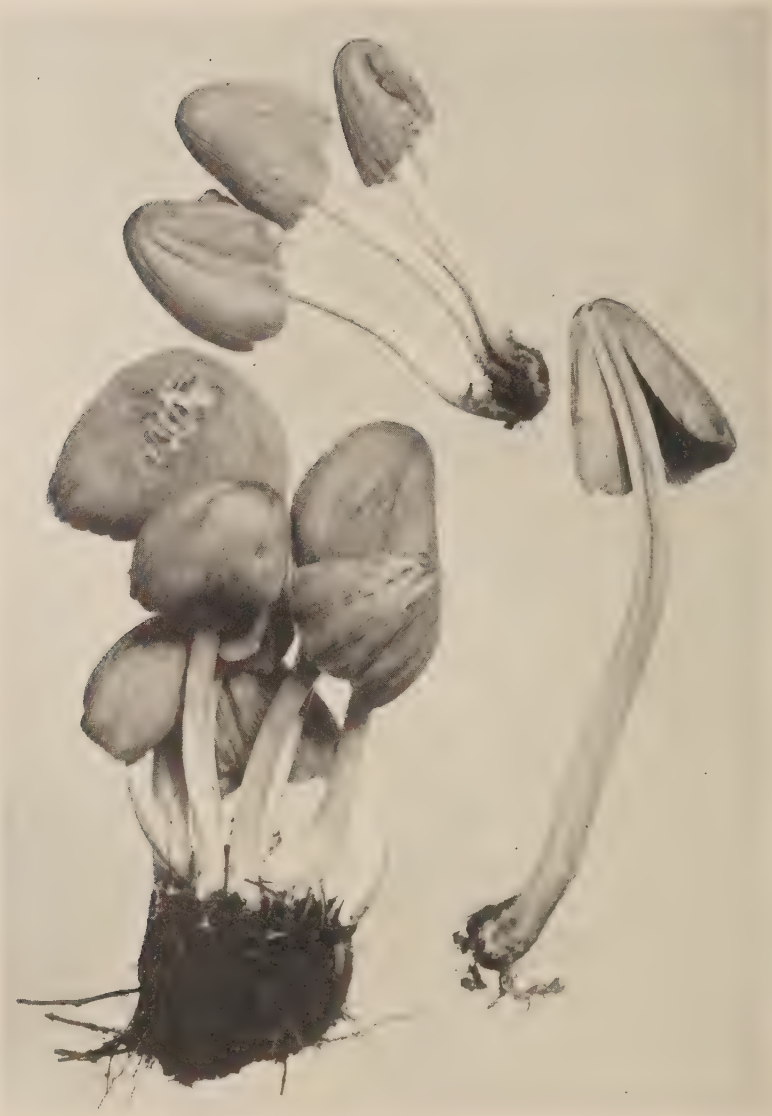

PLATE II.—THE MICA INK-CAP (*Caprinus micaceus*).

The plant at the right is split lengthwise to show the shape of the gills and the hollow stem. Natural size.

TABLE 2.—*Continued.*

DATE	RAINFALL AND WATERING	YIELD OF *Coprinus micaceus*		
		Time of harvesting	Yield	Remarks
	Inches		*Ounces*	
July 11		Evening	2.0	
12		Morning	2.5	Fifth crop on south side.
12		Evening	3.0	
13		Noon	3.0	
15	0.40			
16	0.50	Morning	1.5	
18		Morning	0.5	
19		Morning	4.5	Seventh crop on east side.
19		Morning	1.5	
19		Evening	3.0	
20	Watered	Morning	2.0	
20		Evening	2.5	
21	Watered	Morning	1.5	Part on east, part on south side.
22	Watered			
25	Watered	Morning	1.5	
26	Watered	Evening	1.5	
27		Morning	6.0	
27		Noon	8.0	Sixth crop on south side including
27		Evening	6.0	some on east side.
28	0.31	Morning	12.0	
28		Evening	3.0	
30	0.75			
31		Morning	6.0	Part on west and part on south.
31		Evening	1.5	
Aug. 1		Noon	2.5	
2		Morning	1.0	
3	0.10	Morning	7.0	Eighth crop on east side including
3		Noon	6.0	some on south side.
3		Evening	7.0	
4		Morning	4.0	
8	0.07			
15	0.20			
19	0.12			
22	0.15			
25	0.04			

TABLE 2.—*Continued.*

DATE	RAINFALL AND WATERING	YIELD OF *Coprinus micaceus*		
		Time of harvesting	Yield	Remarks
	Inches		*Ounces*	
Sept. 4	0.05			
5	0.04			
5	Watered			
6	Watered			
7	Watered			
8	0.78			
13		Evening	6.0	
14		Evening	16.0	Seventh crop on south side and ninth
15		Evening	5.0	crop on east side.
16		Evening	2.0	
19	0.10			
20	0.40			
21	0.12			
22	0.60			
27	0.20			
28	0.42	Morning	11.0	
28		Evening	11.0	Eighth crop on south side and tenth
29		Morning	7.5	crop on east side.
30		Morning	6.0	
Oct. 2		Morning	4.0	
3		Evening	2.0	Part on northeast, part on southwest;
6		Evening	1.0	scattering.
12	Watered			
13	Watered			
14	Watered			
14	0.07			
15	Watered			
18		Morning	2.5	
19		Morning	2.0	On the north and northeast.
20		Morning	1.5	
22		Noon	1.0	
24	2.47			
30	0.10			
Nov. 5	0.05			
6	0.05			
7	0.22			

TABLE 2.—*Concluded.*

DATE	RAINFALL AND WATERING	YIELD OF *Coprinus micaceus*		
		Time of harvesting	Yield	Remarks
	Inches		*Ounces*	
Nov. 11	0.08			
22	0.05			
23	0.24			
24	0.05			
26	0.05			
27	0.12			
30	0.60			
Dec. 3		Morning	2.0	On the northeast.

HOW LONG WILL A STUMP BEAR?

When the fungus has once become established in the wood of a stump it persists for a number of years. Where it is found this summer it may be confidently expected to occur again next summer. This is true, also, of many other agarics, as everybody who gathers wild mushrooms for the table well knows. But there must be some limit to the number of seasons during which a stump will continue to bear *Coprinus micaceus* and it would be interesting to know what it is.

There seems to be little definite information upon the subject. Our own observations, made chiefly upon the elm stump mentioned above, lead us to suspect that high production may be expected to continue for only three or four years, altho small colonies of the fungus may be found now and then over a considerably longer period. Records of observations made during the first three seasons after the tree was felled are too incomplete to warrant the positive statement that no *C. micaceus* appeared about the stump prior to 1922, but it is certain that the fungus was not found in quantity until May, 1922. Since June 1, 1922, the stump has been under constant observation and a record has been made of every kind of fleshy fungus occurring on or about it. In 1922, 1923, and 1924 several large crops of *C. micaceus* were obtained each season, production being confined chiefly to the south and east sides of the stump. But during the season of 1925 production on the south and east sides ceased almost completely. Thru the whole season of 1925 nothing whatever appeared on the

south side, while on the east side there were only two small colonies on May 21 and two plants on September 21. However, a small area on the northeast produced fairly well and small colonies appeared also on the north and northwest. During the spring of 1926 the northeast section continued to produce sparingly, but up to July 1, 1926, nothing had appeared on the south or east. Whether the north, northwest, and west sections will ultimately come into good bearing remains to be seen. This region is occupied each season by successive crops of a small, gray mushroom (*Psathyrella disseminata*) which may have something to do with the scarcity of *C. micaceus* here.

Some observations of the writer on the site of a willow bush are of interest in this connection. The willow bush (*Salix purpurea*) was a dense cluster of 15 or 20 small trees about 12 feet high and with trunks 2 to 4 inches in diameter at the base. At the surface of the soil the cluster of willow trunks occupied an area about 5 feet in diameter. The willow bush grew in a lawn on low-lying damp soil near a small stream. In 1919 the trees were cut off a few inches below the surface of the ground, the exposed roots covered with soil, and the spot seeded with grass. The sprouts which came up were kept cut short by the frequent use of the lawn mower until, finally, no more appeared.

There is no record of what happened in 1920, but in the spring of 1921 *Coprinus micaceus* began to appear in quantity. Large crops were harvested on April 23 and May 13. Altho no further records were made in 1921, it is safe to assume that there were some later crops of the fungus that season. In 1922 there were eight separate crops on the following dates: May 7, May 19, June 1, June 22, July 3, July 23, July 31, and August 7. The first, second, fourth, and eighth crops were large, the others small. On June 22, 38 ounces of caps were taken at one time. The large crop of August 7 was brought out by heavy showers on August 5 and 6.

During a heavy rain (5 inches) on the night of August 23, 1922, the nearby creek overflowed and the site of the willow bush was submerged for four days. The grass was not injured, but *Coprinus micaceus* appears to have been nearly or quite exterminated by the flood. Altho conditions for the growth of the fungus were favorable during the fall of 1922 and also in the spring of 1923, no further sign of *C. micaceus* was seen on the site of the willow bush until June 13, 1923, when one small cluster appeared. Another small cluster was found on July 1, and on September 28 and 29 a crop of 10 ounces

was harvested. It is quite possible that all of the plants appearing in 1923 resulted from reinfection of the willow roots after the deluge of August 23, 1922.

The record for 1924 is incomplete, but it is known positively that clusters were found on June 15 and June 25. Seven crops, all small ones, are recorded for 1925. In 1926 three small crops appeared before July 1. So we have here evidence of the occurrence of *C. micaceus* in greater or less quantity on the same spot in six consecutive seasons.

AUTODIGESTION EXPERIMENTS

The process by which the gills of the Coprini are converted into a liquid resembling black ink has been studied in considerable detail by Buller (1, 2) who used for the purpose chiefly *Coprinus comatus* and *C. sterquilinus*. He points out that the name "deliquescence" which is often applied to it is inappropriate since it has nothing in common with the phenomenon of deliquescence of crystals known to chemists. He says the liquid is not derived from the water vapor of the air, but produced, probably, by the action of digestive enzyms on the solid parts of the gill and that the phenomenon is, in reality, a process of autodigestion. Later investigations by Weir (18) tend to support this view. By demonstrating that the inky-looking liquid contains very few spores Buller exploded the idea, long current, that the dark color of the liquid is due to the black spores which it contains. He proved, also, that in general the spores of Coprini are dispersed by currents of air like the spores of other agarics, rather than by insects as has sometimes been stated.

Our own studies of autodigestion have consisted chiefly of a few experiments designed to determine the quantity of liquid which is produced by a given weight of *Coprinus micaceus* caps and the rate at which the autodigestion proceeds.

EXPERIMENT NO. I

On May 13, 1925, 61 nice, fresh caps were harvested. The gills of all were white, but in almost every case they were about ready to begin their color change. The stems were removed by cutting them off close to the lower margin of the cap. The weight of the 61 caps was then 102.4 grams. They were at once put into a funnel set in the top of a 100 cc. graduate, a damp paper placed over the funnel, and the whole apparatus covered with a bell jar.

The experiment was started at 9:30 a. m. Five hours later the first drop of liquid appeared at the lower end of the funnel, but even at 5 p. m., or seven and a half hours from the start, the drip was very slow. The following morning, 22 hours after starting, there were 39 cc. of liquid in the graduate. Twenty-four hours from the start there were 47.5 cc. of liquid. At the end of 26.5 hours the amount had increased to 49 cc.; at the end of 29 hours, to 50 cc.; at 31.5 hours, to 60 cc.; at 35 hours, to 65 cc.; at 46 hours, to 71 cc.; and at 52 hours, to 73 cc. The experiment was closed at 4:30 p. m., May 15, 55 hours from the start with 73.5 cc. of reddish brown liquid in the graduate. Accordingly, the yield of liquid in this experiment was at the rate of 71.7 cc. per 100 grams of caps. During the experiment the temperature of the room varied from 70° to 72°F. There was no sediment in the bottom of the graduate.

EXPERIMENT NO. II

In this experiment use was made of 156 caps having a total weight of 175.7 grams after the stems had been removed by cutting them off close to the caps as in the previous experiment. In most of the caps the gills were still white, but in a few the tips of the gills had just commenced to turn brown. The apparatus used was essentially like that used in the first experiment, but the funnel was larger and the 100 cc. graduate was replaced by one having a capacity of 250 cc. The experiment was started at 3 p. m. on July 2. At the end of seven hours dripping had not yet begun. At the end of 16.5 hours, when the next observation was made, there were 10 cc. of liquid. At 21 hours the quantity had risen to 60 cc.; at 25 hours, to 96 cc.; at 26 hours, to 104 cc.; at 30.5 hours, to 120 cc.; and at 40 hours, to 130 cc. Here the experiment was closed. Had it been continued longer only a few more drops of liquid would have been obtained. The yield of liquid in this experiment was at the rate of 74 cc. per 100 grams of caps. The temperature during the experiment was almost constantly 72°F. The color of the liquid was reddish brown. After standing two days it had an odor suggestive of alcohol, there was a small quantity of black sediment, and a thin layer on the surface was distinctly darker in color. Upon standing four days longer the color of the liquid changed only slightly. Neither was the color changed by passing the liquid thru filter paper. It was still reddish brown.

EXPERIMENT NO. III

In the preceding two experiments the upper parts of the stems were included with the caps. It was now sought to learn what the effect would be of removing the stems completely. For this purpose, a lot of 205 caps was used. The caps were gathered in the morning after a heavy shower. They were at a stage of maturity closely comparable to that of the caps used in the preceding experiment.

After the stems had been cut off closely the 205 caps weighed 240 grams. Each cap was then carefully divided into two or three parts and the remaining bit of stem removed. When this was completed the total weight of the cap pieces was 204 grams. They were then put into an apparatus like that used in the preceding experiment except that the funnel was corrugated and lined with filter paper. The experiment was started at 11:30 a. m., September 18. The first drop of liquid fell four hours later. At 20.5 hours from the start there were 98 cc. of liquid in the graduate; at 22.5 hours, 116 cc.; at 24.5 hours, 132 cc.; at 28.5 hours, 152 cc.; at 32.5 hours, 162 cc.; and at 43.5 hours, 172 cc. The digestion was now finished except for about ten pieces which, for some unknown reason, remained practically unchanged. There was no sediment in the bottom of the graduate. During the first third of the experiment period the temperature was 74°F., during the second third, 71°F., and during the last third 70°F. The color of the liquid was light reddish brown—the color of cider. The yield of liquid was at the rate of 71.7 cc. per 100 grams of caps before the upper parts of the stems were removed, or 84.3 cc. per 100 grams of caps after removal of the stems. Apparently, the mutilation of the caps and removal of the stems had no effect upon the digestion. Comparing this result with those obtained in previous experiments it appears that the stems participate in the digestion only to a very small extent if at all. Whether the stems be present or absent the color of the undigested residue remaining in the funnel is black.

It is impossible, from the experiments, to determine accurately the length of time required for a cap of *C. micaceus* to accomplish its autodigestion, because the caps used were not all in exactly the same stage of maturity at the beginning. Moreover, it is difficult to determine accurately either the commencement or the ending of autodigestion, and temperature and humidity are probably factors of some importance. But under the conditions of the experiments, the time between the fall of the first and the last drops of liquid

varied from about 40 to about 50 hours, and the period of greatest activity seems to have occurred from 16 to 22 hours after the fall of the first drop.

The liquid which results from the autodigestion of the gills of the Coprini is usually described as "inky," "ink-like," or "resembling black ink." When caps of *Coprinus micaceus* are allowed to lie in a white dish until the process of autodigestion is well advanced the liquid produced will appear to be black. Likewise, when partly digested caps are washed in preparation for cooking the wash-water becomes distinctly black. But when the liquid of autodigestion is collected by the methods used in the experiments described above its color is light reddish brown. Undoubtedly, light reddish brown is the color of the pure liquid. Apparently, it is the admixture of dark brown spores and particles of the black undigested residue which makes the liquid appear black.

When fresh, the liquid has no pronounced odor or taste. Upon exposure to the air it soon becomes foul smelling, thru the action of putrefactive bacteria, but fungi do not grow in it.

INOCULATION EXPERIMENTS

Those who prize the mica ink-cap as an article of food will desire to encourage its growth about stumps in the vicinity of their homes and the question naturally arises, How is this to be done?

First of all, it should be stated that the spores are the reproductive bodies of mushrooms as seeds are the reproductive bodies of the higher plants; also, that mushroom spores, like weed seeds, are disseminated by wind and water and other natural agencies. It is possible that the mica ink-cap, like certain weeds, is so widely and abundantly distributed that natural agencies are amply sufficient to establish it wherever the conditions are favorable for its growth and that it is unnecessary to plant it. On the other hand, it may be possible for man to assist nature in its dissemination and cultivation as has been done with many other food plants, including some kinds of mushrooms. Of course the highly perishable character of the mica ink-cap makes it worthless as a market mushroom. It has value for home use only. Consequently, simple and inexpensive aids to its cultivation are the only ones likely to receive consideration by the public.

Quite naturally, the first thing one thinks of for trial is to "plant" the fungus where one wishes to have it grow. This idea is easily carried out. Two methods suggest themselves: (a) Scattering the

caps about stumps, and (b) digging up and transplanting colonies of the fungus to the vicinity of stumps. Altho "planting" or inoculation experiments of this kind appear simple, it is, in reality, very difficult to so conduct them as to prove that the fungus can be propagated by such methods. Owing to the fact that *Coprinus micaceus* often grows naturally about stumps it is difficult to prove that the fungus appearing about an inoculated stump did not result from natural infection. It is difficult to secure checks or controls such as are necessary in this kind of experimentation. If one might obtain for experimental purposes a large number of stumps of one kind, close together, and under parallel conditions, it is possible that by inoculating one-half the number and using the others for checks a conclusion might be reached concerning the efficiency of artificial inoculation; but, unfortunately, such opportunities are rare.

Two experiments made by the writer are, perhaps, worth relating because they show methods which have failed. In one experiment the stump used was maple, about 15 inches in diameter, and well advanced in decay. It stood in well-drained, fertile soil in a cow pasture and was closely surrounded by short grass. On May 9, 1922, it was inoculated with *Coprinus micaceus* by the following method: Several handfuls (about a quart altogether) of caps were placed on the ground close about the stump, some in actual contact with the wood, and one in a small decayed cavity in the top of the stump. Several shovelfuls of fresh cow manure were scattered about the stump and over the fungus. Finally, two pailfuls of water were poured over the stump and surrounding soil. Additional waterings were made on May 13 and 15 and there were rains on May 18, 19, and 25. Also, there was an abundance of rain during June and July. Altho all conditions appeared favorable for infection, no sign of *Coprinus micaceus* has since been seen about the stump. It is now suspected that the stump was too old at the time of inoculation. Its age is unknown, but it had already begun to break down in places at the time of inoculation and was completely decayed within two or three years afterward.

In another experiment, an attempt was made to infect a large year-old cottonwood stump with *Coprinus micaceus*. On April 29, 1925, a cluster of seven plants was dug from a lawn and transplanted into the soil at the base of the stump, and on May 2, 13, and 14, 1925, handfuls of *C. micaceus* caps were buried in the soil at several points close about the stump. Another cottonwood stump of the same age

and size, about 75 feet distant, and untreated, served as a check. In October, 1925, a crop of the large ink-cap (*Coprinus atramentarius*) came up at three of the points of inoculation, but no *Coprinus micaceus* has appeared anywhere about the inoculated stump up to July 1, 1926. No plants of either species have been seen about the check stump. The scriptural adage, "As ye sow so shall ye reap," appears not to have held true in this case. We have here an example of the difficulties encountered in such experiments. Had we planted *C. atramentarius* instead of *C. micaceus*, the result would have been the same and we might have concluded that inoculation had been successful, whereas, actually, the October crop of *C. atramentarius* had no relation, whatever, to our inoculation.

Notwithstanding the lack of proof that *C. micaceus* can be propagated by scattering or planting the caps about stumps, the practice is to be recommended because it is sound theoretically and involves very little labor. Doubtless there are means, if we only knew them, whereby some of the obstacles to infection might be readily overcome; but, as has been stated, experimentation along this line is beset with difficulties.

AN ERADICATION EXPERIMENT

According to our view, the best way to get rid of mica ink-cap mushrooms is to cook and eat them, but some people do not approve of this method. To some they are loathsome objects which mar the appearance of the lawn and should be destroyed to prevent somebody being poisoned by them. Also, they are sometimes suspected (unjustly, we believe) of affecting injuriously the growth of grass. Requests for information concerning methods of eradicating them are occasionally received by the Station.

The suggestion of Shantz and Piemeisel (17) that applications of bordeaux mixture to the soil should be effective for the control of fungi which cause fairy rings, led the writer to try bordeaux mixture for the eradication of *Coprinus micaceus*.

On July 22, 1925, in one of the Station lawns where three crops of *C. micaceus* had appeared at intervals during the preceding three months, a rectangular plat, 3 by 4 feet, was laid out in such a way as to include about 40 scattered plants of a crop of *C. micaceus* showing at that time. The soil was moist from a shower which fell the night before. Four gallons of 5–5–50 bordeaux mixture were poured over the plat, care being taken to make the application uniformly

over the whole area. Simultaneously, with the appearance of the next crop of *C. micaceus* in the lawn, on July 28, nine plants were found at two points in the treated area.

On August 4, there were 29 plants at three points in the treated area and again, on June 21, 1926, there were 32 plants at three points. Plainly, the treatment was ineffective. There was no indication that the grass had been injured by the treatment.

ENEMIES

The caps of *Coprinus micaceus* have no fungous parasites and are rarely infested by insect larvae. They develop so rapidly that neither fungi nor insects have time to breed in them. But the caps are often mutilated by slugs which feed upon them.

PREPARATION FOR THE TABLE

The caps should be gathered before the gills blacken. The best method of harvesting is by means of scissors, cutting off the stems close to the margin of the caps. A good way to clean the caps is as follows: Place them in a deep pan of water and stir vigorously to dislodge adhering particles of soil and blades of grass. The soil particles will sink while the caps and grass float. With the hands, the caps are lifted out of the water, leaving behind as much of the grass as possible, and placed in a second pan of water where the process of stirring and lifting the caps is repeated. Usually, two or three changes of water are sufficient, the whole operation requiring but a few minutes.

At the last rinsing the caps are put into a frying pan, salted, and boiled slowly until the water in the pan has nearly, but not quite, all disappeared. Then butter and pepper are added and the caps fried for 10 or 15 minutes. The whole process of cooking requires from 20 to 30 minutes.

The caps are composed very largely of water which oozes out into the frying pan as heat is applied. The quantity of water thus obtained is sufficient for the cooking of the caps unless the boiling and consequent evaporation are very rapid, in which case it may be necessary to add a little extra water. With slight modifications, principally in the length of time required for boiling, the above simple method of cooking is applicable to many kinds of fleshy fungi. It is a favorite with the writer. But there are also other methods of cooking mushrooms. Almost every mushroom book includes a chapter

on recipes for cooking the various kinds of mushrooms. From such sources we have copied three which apply especially to *Coprinus micaceus*.

The first, by Mrs. S. T. Rorer (16), is as follows: "Wash and dry the mushrooms; put them into a deep saucepan with a tablespoonful of butter to each quart; stand over a quick fire sort of tossing the saucepan. Do not stir or you will break the mushrooms. As soon as they have reached the boiling point, push them to the back part of the stove for five minutes; serve on toast."

The next, given by McIlvaine and Mac Adam (8), is also credited to Mrs. Rorer: "Trim the stems, wash the toadstools carefully thru several waters, then drain them in a colander. Spread them out in a long baking pan, dust lightly with salt, pepper, put over a few bits of butter, cover with another pan and bake in a moderate oven for twenty-five minutes. Add four tablespoonfuls of cream, bring to boiling point; dish on toast."

The third is given by Patterson and Charles (12): "Butter a baking dish and put in a layer of mushrooms, bread crumbs, cheese grated (or cut in small pieces), and season with pepper and salt. Repeat the process once or twice according to the amount to be prepared, adding a few small lumps of butter to the last layer. Bake 15 to 20 minutes."

Coprinus micaceus is so perishable that it cannot be kept in the natural state more than three or four hours. If it is not to be used at once it should be partially cooked, by the method first described, and put into the refrigerator. In this way it may be kept considerably longer and warmed up for use as needed, but it is inadvisable to try to keep it longer than 12 or 15 hours in any case. The caps may be canned for winter use, but they cannot be successfully dried.

DIGESTIBILITY AND NUTRITIVE VALUE

As a class, the fleshy fungi are considered somewhat difficult of digestion (6); but, according to various authors, the species of Coprinus are exceptions to the rule. McDougall (7) says, "All species of the genus Coprinus are very easily digestible, and the glistening Coprinus has been said to be the most easily digestible mushroom that grows." Our own experience and observation indicate that *C. micaceus* is comparatively easy of digestion.

In some of the older mushroom literature the food value of mushrooms has been much overrated; for example, Gibson (3, p. 14)

declares that they possess the same nourishing properties as meat. Also, he quotes (3, p. 301) Dr. M. A. Curtis as stating that, in some parts of North Carolina, a regiment of soldiers could be maintained for five months of the year upon mushrooms alone. Even Peck (14, p. 211) says, "The general opinion is that mushrooms constitute a very nutritious and sustaining diet."

The present view is that the nutritive value of mushrooms is quite low. Mendel (9, p. 238), who has made chemical analyses of several common species of edible fungi and also conducted artificial digestion experiments with them, says. "The fungi thus form no exception to the ordinary classes of fresh vegetable foods; indeed, they take a decidedly inferior rank in comparison with many. * * * As dietetic accessories the edible fungi may play an important part; but investigation has demonstrated that they cannot be ranked with the essential foods." *Coprinus micaceus* was not among the species investigated by Mendel, but there appears to be no reason for believing that it is any more nutritious than the two other species of Coprinus which were included.

Hara (4) has demonstrated the presence of the growth-promoting vitamin B in some of the edible fungi, but *Coprinus micaceus* has not been investigated in this respect.

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